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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁵ : B21J 5/02, 5/08, B21K 1/46</p>	<p>A1</p>	<p>(11) International Publication Number: WO 93/17808 (43) International Publication Date: 16 September 1993 (16.09.93)</p>
<p>(21) International Application Number: PCT/DK93/00079 (22) International Filing Date: 3 March 1993 (03.03.93) (30) Priority data: 0280/92 3 March 1992 (03.03.92) DK (71) Applicant (for all designated States except US): ENKOTEC A/S [DK/DK]; Danmarksvej 37, DK-8660 Skanderborg (DK). (72) Inventor; and (75) Inventor/Applicant (for US only) : NIELSEN, Ove [DK/DK]; Borgergade 21, DK-8660 Skanderborg (DK). (74) Agent: HOFMAN-BANG & BOUTARD A/S; Adelgade 15, DK-1304 Copenhagen K (DK).</p>		<p>(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG). Published With international search report.</p>
<p>(54) Title: A METHOD AND AN APPARATUS FOR MAKING A HEAD ON AN ELONGATE BLANK</p> <div data-bbox="738 1496 1692 2187"> </div> <p>(57) Abstract</p> <p>In a method of making a head on an elongate blank (26) a blank (26) is moved into a die (16) having a bottom stop (28) such that part of the blank (26) extends outside the die (16) end opposite the bottom stop (28), following which the protruding part of the blank (26) is formed by a pre-upsetter (25) having a pre-upsetting bushing positioned in extension of the die (16) and a punch (27) slidably movable in said pre-upsetting bushing, said pre-upsetter (25) and said die (16) being moved away from each other during part of the forming procedure. The movement of both the punch (27) and the pre-upsetter (25) with respect to the die (16) is positively controlled so that the pre-upsetter (25) and the die (16) are moved away from each other at the end of the forming procedure, while the punch (27) continues to press in a direction toward the die (16). An apparatus for making a head on an elongate blank (26) comprises means for positively controlling the movement of both the punch (27) and the pre-upsetter (25) with respect to the die (16), so that the pre-upsetter (25) is moved away from the die (16) at the end of the forming procedure, while the punch (27) continues to press in a direction toward the die (16).</p>		

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A method and an apparatus for making a head on an elongate blank

5 The invention concerns a method and an apparatus for making a head on an elongate blank, wherein a blank is moved into a die having a bottom stop such that part of the blank extends outside the die end opposite the bottom stop. The protruding part of the blank is then formed by a
10 pre-upsetter which has a pre-upsetting bushing positioned in extension of the die, and a punch capable of being displaced in the pre-upsetting bushing, said pre-upsetter and said die being moved away from each other during part of the forming procedure.

15

For pre-upsetting of a head on an elongate blank it is known to place a wire blank in a die having a bottom stop, e.g. in the form of an ejector pin, following which the blank is formed by means of a punch in a pre-upsetter.

20

To obtain optimum quality of the head and to avoid deflection of the blank during the upsetting process, it is of decisive importance that the free length of the wire blank between the die and the pre-upsetter is sufficiently
25 small. Since, however, a large volume in the head is frequently desired, this distance is usually increased to the maximum length. It is frequently desired at the same time that pre-upsetting proceeds to a great diameter, which increases the load on the pre-upsetter pin. These circumstances limit the maximum upsetting ratio that can be
30 achieved, said upsetting ratio being the length of the wire outside the retention of the die divided by the wire diameter. It is desirable to achieve an upsetting ratio as great as possible.

35

In an embodiment, which is defined in claim 2, the punch movement is controlled by a cam disc having pre-calculated curve paths. These curve paths are calculated precisely so that the upsetting process will be optimum, because the movement of the punch does not follow the movement of the forming mechanism.

An apparatus for performing the method comprises means which can positively control the movement of the punch as well as the pre-upsetter with respect to the die, so that the pre-upsetter is moved away from the die at the end of the working procedure, while the punch continues to press in a direction toward the die.

A particular embodiment of the apparatus, which is mentioned in claim 4, comprises a cam disc having pre-calculated curve paths for controlling the movement of the punch.

In the embodiment defined in claim 5, the pre-upsetter is retained with respect to the base of the apparatus, and it is thus the punch and the die which are moved with respect to the pre-upsetter. This provides the advantage that the pre-upsetter may be a bushing which is also used as a cropping bushing in the production of the employed blanks from a wire, and the further advantage that also the other tools used in later process steps may be stationary with respect to the base of the apparatus.

When, as stated in claim 6, also the bottom stop of the die is movable, the blank can be subjected to pressure from both ends at the same time, enabling better control of the forming of the material.

The mentioned movements can be provided either by the provision of separate motors for each of the movements, as

fig. 14 shows the use of a slot detector,

fig. 15 shows the making of a holding flange,

5 fig. 16 shows a mechanism which converts a rotary movement to a reciprocating movement,

fig. 17 shows an alternative embodiment of the mechanism from fig. 16,

10

fig. 18 is a sketch of a crank and a connection rod,

fig. 19 are curves showing motion and speed of a crank mechanism,

15

fig. 20 shows how the die table can be controlled by a curve path,

20

fig. 21 shows motion and speed of the die table and bottom stop without transition periods,

fig. 22 corresponds to fig. 21, but with inserted transition periods,

25 fig. 23 corresponds to fig. 22, but without a dwell period,

fig. 24 shows the mounting of a die in a die table,

30 fig. 25 is a section through a die table with a die, and

fig. 26 shows how a die table can be constructed.

35 Fig. 1 shows an example of a screw machine in which the invention may be used. The machine is mounted on a base plate 1 and generally consists of three main parts, viz. a

The rotating movement of the die table 17 can be established by a motor 18 adapted for the purpose. Its axial movement is provided from the crank mechanism 4 and is driven by the previously mentioned motor 5. Power transmission from the motor 5 to the crank mechanism 4 takes place by means of a pulley 19 and a belt 20.

By means of two pulleys 21, 22 which are connected to a motor (not shown), the entire tool table 2 can be moved in a direction away from or toward the die table 17, the tool table 2 being guided by a slide bar 23 on the under side of the tool table and a corresponding one (not visible in the figure) on the upper side. The tool table 2 can hereby be adjusted to its correct position, and it is also possible to draw the tool table away from the die table 17 in case of e.g. replacement of tools or die table.

The individual parts or processes in the machine will be described more fully below.

It is shown in figs. 2 and 3 how cropping and pre-upsetting take place. Fig. 2 is a cross-section of the constituent parts, while fig. 3 is a perspective view.

The wire 6 is moved forwardly through the stationary cropping bushing 14 and into a movable cropping bushing 24 which, as mentioned before, is mounted in a rotatable cropping table 15. The cropping table 15 has a plurality of movable cropping bushings 24, 25. When the wire 6 has been moved forwardly to the correct length, the rotatable cropping table 15 is rotated, causing a wire blank to be separated from the wire 6. Further rotation of the cropping table 15 moves the movable cropping bushing forwardly to a position opposite a die 16, here shown at the cropping bushing 25. The released wire blank is here designated 26.

cropping table 15.

It is shown more clearly in fig. 4 how the pre-upsetting process proceeds. As described before, the die 16, which
5 is mounted in the die table 17, is moved together with the associated bottom stop 28 in the axial direction of the die. On the other hand, the movable cropping bushing 25 cannot be moved in the axial direction. Fig. 4A shows the situation precisely at the time when pre-upsetting is
10 initiated. The pre-upsetting pin 27 pushes the wire blank 26 out of the bushing 25 and into the die 16 such that the blank 26 reaches the bottom stop 28 immediately before the die 16 at its turning point is in contact with the pre-upsetting bushing 25. An expansion 29 of the hole in the
15 pre-upsetting bushing is provided at the end of the bushing 25 facing the die 16. A corresponding expansion 30 is provided in the die 16. These cavities enable pre-forming of a head on the wire blank 26.

20 These cavities are shaped so that the free length l of the wire blank 26 will be as small as possible with respect to the diameter d of the blank. The pre-upsetting pin 27 is controlled so that pre-upsetting continues after the die 16 has again initiated its movement away from the bushing
25 25. This gives an increased height of the pre-upset while increasing the diameter of the pre-form, so that the volume of the pre-formed material can be increased without the pre-form becoming unstable, so that the upsetting ratio is not restricted by the process. The upsetting ratio is the head wire length divided by the wire diameter.
30 Fig. 4B shows the situation at the termination of the pre-upsetting process. The pre-formed head now has the height L and the diameter D . In addition to a greater upsetting ratio, this method also results in reduced loads on the
35 pre-upsetting pin. Fig. 5 shows an alternative embodiment, using instead of the bottom stop 28 a movable bottom stop,

When the pre-upsetting process, which can also be called first pre-forming here, has been terminated and the die table 17 has been drawn back, the table can be rotated to a new position. In the embodiment of the rotatable die table 17 shown in fig. 1, where said table comprises five dies 16, the die table will now be rotated 72°, so that a new die is moved forwardly to the position opposite a movable cropping bushing, while the die having just been present here is moved forwardly to a new position. When the die table 17 is again moved forwardly toward the tool table 2, the process described above will be repeated at the cropping or pre-upsetting bushing, while further shaping of the blanks arranged in the dies will take place at the other die positions.

15

Fig. 9 shows an example of a process which can follow the pre-upsetting process described above. The process shown here is called second pre-forming. Fig. 9A shows the situation at the beginning of this process, while fig. 9B correspondingly shows the situation immediately after it has been completed. In fig. 9A a blank is placed in a die 45 which, together with a bottom stop 46, is moved toward a tool 47. The tool 47 is positioned stationarily on the tool table 2, while, as described before, it is the die 45 arranged in the die table 17 which moves toward and then away from the tool 47. When the head on the blank 44 hits the tool 47, it will be formed to the desired shape by a depression 48 in this tool. It is shown in fig. 9B how the blank 44 has now been formed to the blank 49 shown here. The blank 49 together with the die 45 and the bottom stop 46 are being moved away from the tool 47.

Fig. 10 correspondingly shows a forming that may take place at a third die position. In this process a slot or the like is produced in the screw head just formed. The blank 49 is now present in a die 50 which, together with a

applied in the production of screws without points. In that case, the depression 56 is shaped as a cylindrical depression having the same diameter as the hole in the die 50, or a bottom stop with a projection extending into the die may be used, said bottom stop being then merely moved slightly backwards from the die when the slot projection 53 produces the slot in the head of the blank.

An interesting aspect of the mentioned flow of material down through the shank of the blank is the part of the flow that takes place at the transition between the head and shank of the blank. The reason is that this flow has been found to strengthen the weak point which, otherwise, is traditionally found in screws at this transition.

In case of certain types of points it may be necessary or advantageous to produce the point in two steps. If so, a first depression is shaped in the bottom stop 46 which is used in the second pre-forming of the head of the screw blank.

It is described above how a blank can be formed in three die positions. This, however, is merely an example, since the three positions may be used flexibly depending upon the shape of the desired objects, or if necessary, more than three positions may be used for the forming.

In the machine shown in fig. 1 with five dies in the die table 17 and thus correspondingly five positions for each die, the last two positions may be used for ejection of the blank, and this ejection can then take place in two steps. Fig. 12 shows the first step of this ejection and thus corresponds to the fourth die position. A blank 57 placed in a die 58 is visible at the top of the figure, which shows the situation immediately before ejection. A bottom stop 59 with a short ejector pin 60 is being moved

before and shown in fig. 11, will be produced by means of a depression in the corresponding bottom stop 55. In the past, it was necessary to produce such a point by making a constriction in the die itself, and an ejector pin could
5 only have a diameter corresponding to the narrowest portion of the die.

Since, as shown in fig. 12, the short ejector pin 60 pushes the blank 57 a short and well-defined distance out
10 of the die, this may be utilized for controlling the blank produced. Fig. 14 shows an example of how this may be done. The figure corresponds to fig. 12, but includes a slot detector 63 comprising a control bit 64 which is arranged at a carefully determined distance from the die
15 58. The slot detector 63 is connected via a connection wire 65 to electronic equipment capable of processing the signals emitted from the slot detector 63. It is shown at the bottom of the figure how the short ejector pin 60 has pushed the blank 57 out of the die 58, and that the blank
20 contacts the control bit 64. If the slot projection 53, by means of which the slot in the screw was made, has e.g. been damaged, the slot may be too small, and the blank 57 will then exert a pressure against the control bit 64. This is registered by the slot detector 63 which transmits
25 signals about this to a control unit via the connecting wire 65. Thus, in this manner it is possible to control the geometry of the produced blanks.

Since the blank has been pushed out of the die, it is also
30 possible to control e.g. the height or diameter of the head in addition to a possible slot.

Furthermore, the distance between the die and the tool table may be detected, and the signals from the detector
35 63 may be used for adjusting the tools. When the machine starts from a cold state, the machine parts will be heated

pulled out of the die at an inappropriate time. The flange or the projections are just large enough to prevent this and also small enough for an ejector pin, in the subsequent ejection of the blank, to be able to deform the flange or the projections and eject the blank from the die.

It is shown in fig. 16 how the reciprocating movement of the die table 17 and the associated bottom stops can be established. As described before and shown in fig. 1, this axial movement is provided by a motor 5, and the power transmission from the motor 5 takes place via belts 19, 20 and a crank mechanism 4. Fig. 16 shows in greater detail how this mechanism is constructed.

A crank 71 rotates about its axis of rotation 72 and is driven by the belt 20, as mentioned. A connecting rod 73 is secured to the crank 71 at one end and to a holder 74 at the other. When the crank 71 rotates, the rotating movement is converted via the connecting rod 73 to a reciprocating movement of the holder 74. The holder 74 is connected with two wedges 77, 78 via two rods 75, 76 such that these wedges, too, can be reciprocated. For this reciprocating movement to take place with a very small friction, a plurality of rollers 81 and 82, respectively, are positioned between the wedges 77, 78 and guide rails 79, 80. A bearing block 83 is interposed between the two wedges 77, 78, which is capable of being moved in a direction transversely to the direction of travel of the wedges. This movement, too, can take place with a very small friction, because rollers 84 and 85, respectively, are arranged between the bearing block and the guide rails 86, 87. Finally, a plurality of rollers 88 are also provided between the bearing block and the wedge 77 as well as a plurality of rollers 89 between the bearing block 83 and the wedge 78. When the wedges 77, 78 are moved to the

It is of great importance that the production rate of a machine of the type described here can be as high as possible. At the same time, the speed of the die at the beginning of the actual forming should be as low as possible. This is achieved i.a. by using a wedge mechanism, as described above, the wedge angle being selected such that the movement of the bearing block and thereby of the die table has a relatively small length of stroke. Furthermore, the velocity at which the die table approaches its extreme positions in such a movement differs. This is shown in figs. 18 and 19.

Fig. 18 schematically shows a crank mechanism. The crank rotates about an axis of rotation C. At its one end a connecting rod of the length a is secured to the crank at a distance r from its center or axis of rotation. Rotation of the crank causes the point P, which designates the other end of the connecting rod, to perform a reciprocating movement on the horizontal line. l designates the distance from the axis of rotation C to the point P. The distance l is shown at the top of fig. 19 as the function of time at a constant crank speed of rotation. If the length a is very great with respect to the distance r , the point P will perform a pure sine movement, which is shown with the first of the two curves. If, on the other hand, the length a is short with respect to the distance r , the sine curve will be distorted. The smaller a is with respect to r , the more pronounced the distortion is. In the extreme case where a is equal to r , the point P will lie still for half of a period of rotation. The other curve at the top of fig. 19 shows the movement of the point P in the situation where a is equal to 1.2 times r . It will be seen that the point P relatively slowly approaches the extreme position which is passed at the time t_1 , while, on the other hand, it relatively quickly approaches the other extreme position, as shown at t_0 or t_2 . The bottom of fig.

the die table. It is shown by arrows in the figure that the die table 17, after the contact with the tool 98, is moved away from it in the direction of the arrow while the cam means 96 is moved in an upward direction. As will be
5 seen from the figure, the cam means 96 is provided with a curve path 100, while a roller 99 is mounted on the die table 17.

Fig. 20B shows the situation where the die table 17 together with the bottom stop 97 has been moved away from the tool 98 and is about to hit the cam means 96, which continues its upwardly directed movement. In fig. 20C, the roller 99 has contacted the curve path 100. The curve path 100 is shaped such that together with the speed of the cam
10 means 96 it entails that the die 17, immediately after contact between the roller 99 and the curve path 100, will continue at an unchanged velocity and is then slowly braked. It will be seen from the figure that the bottom stop 97 continues its movement and is therefore no longer
15 in contact with the die table 17. Fig. 20D shows the situation in the extreme position where both the die table 17 and the bottom stop 97 are removed from the tools. The die table 17 is now separated from the bottom stop 97 and can rotate to a new position. Then the process proceeds in the
20 opposite direction. The bottom stop 97 is moved forwardly toward the die table 17, which is simultaneously accelerated because of the cooperation between the curve path 100 and the roller 99, the cam means 96 now moving in a downwardly extending direction. Owing to the shape of the
25 curve path 100 the die table 17, when being hit by the bottom stop 97, will have attained precisely the speed which the bottom stop has at this moment.
30

Figs. 21, 22 and 23 show the movement and the speed of the die table 17 and the bottom stop 97, respectively, in
35 three different situations. The tops of the figures show

steel band around a cylindrical core, which may either be the die 102 itself, which is made of hard metal, or a cylindrical insert. The band winding 103 biases the die 102 by absorbing the outwardly directed forces which occur
5 when the die 102 is subjected to strong compressive stresses in the axial direction.

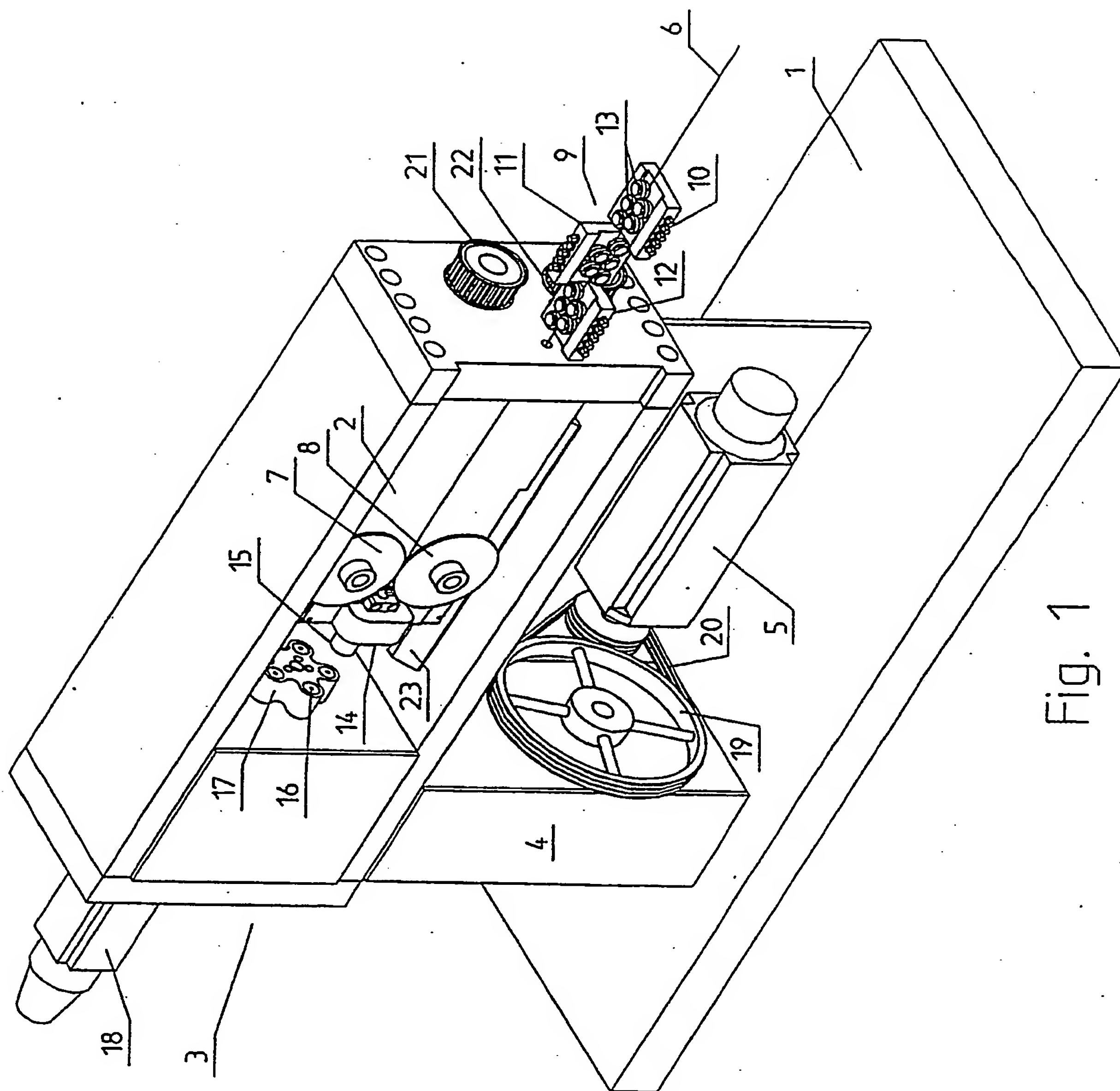
Fig. 25 shows a section through part of the die table 101, and it is shown more clearly in this section how the die
10 102 may be mounted in the die table 101. The die 102 here has a conical shape and is mounted in a bushing 104, whose interior has a conical shape corresponding to that of the die. The bushing 104 is wound with the band winding 103, which is in turn placed in a suitable hole in the die
15 table 101. This structure has the advantage that the die 102, because of the conical shape, can easily be replaced by pressing it out of the bushing 104. A new die can be pressed down into the conical bushing 104 and thus ensure that the die is biased correctly.

20

The advantage of biasing the hard metal die in this manner by means of a band winding is that the die unit, including bias, can be given a very small cross-sectional area. This means that the dies in a die table can be positioned more closely to the axis of rotation of the die
25 table and thus contribute to reducing its moment of inertia. Fig. 26 shows an example of the shape of a die table 101. In this case the die table has five dies, all of which are biased by means of band windings as described
30 above. For a high production rate to be achieved, the die table must have as low a moment of inertia as possible. This is achieved partly in that the dies, including bias by means of band windings, have a modest extent, and partly because they can then be positioned more closely to
35 the axis of rotation 105 of the die table. The moment of inertia of the die table is then additionally diminished

P a t e n t C l a i m s :

1. A method of making a head on an elongate blank (26),
5 wherein a blank (26) is moved into a die (16) having a
bottom stop (28) such that part of the blank (26) extends
outside the die (16) end opposite the bottom stop (28),
following which the protruding part of the blank (26) is
10 formed by a pre-upsetter (25) having a pre-upsetting bush-
ing positioned in extension of the die (16) and a punch
(27) slidably movable in said bushing, said pre-upsetter
(25) and said die (16) being moved away from each other
during part of the forming procedure, c h a r a c t e r -
i z e d in that the movement of both the punch (27) and
15 the pre-upsetter (25) is positively controlled with re-
spect to the die (16) so that the pre-upsetter (25) and
the die (16) are moved away from each other at the end of
the forming procedure, while the punch (27) continues to
press in a direction toward the die (16).
20
2. A method according to claim 1, c h a r a c t e r -
i z e d in that the movement of the punch (27) is con-
trolled by a cam disc (34) having pre-calculated curve
paths.
25
3. An apparatus for making a head on an elongate blank
(26), said apparatus comprising a die (16) having a bottom
stop (28) capable of receiving a blank (26) such that part
of the blank extends outside the die (16) end opposite the
30 bottom stop (28), as well as a pre-upsetter (25) which is
adapted to form the part protruding from the die (16), and
which comprises a pre-upsetting bushing in extension of
the die (16) and a punch (27) slidably movable in the pre-
upsetting bushing, c h a r a c t e r i z e d in that it
35 comprises means for positively controlling the movement of
both the punch (27) and the pre-upsetter (25) with respect



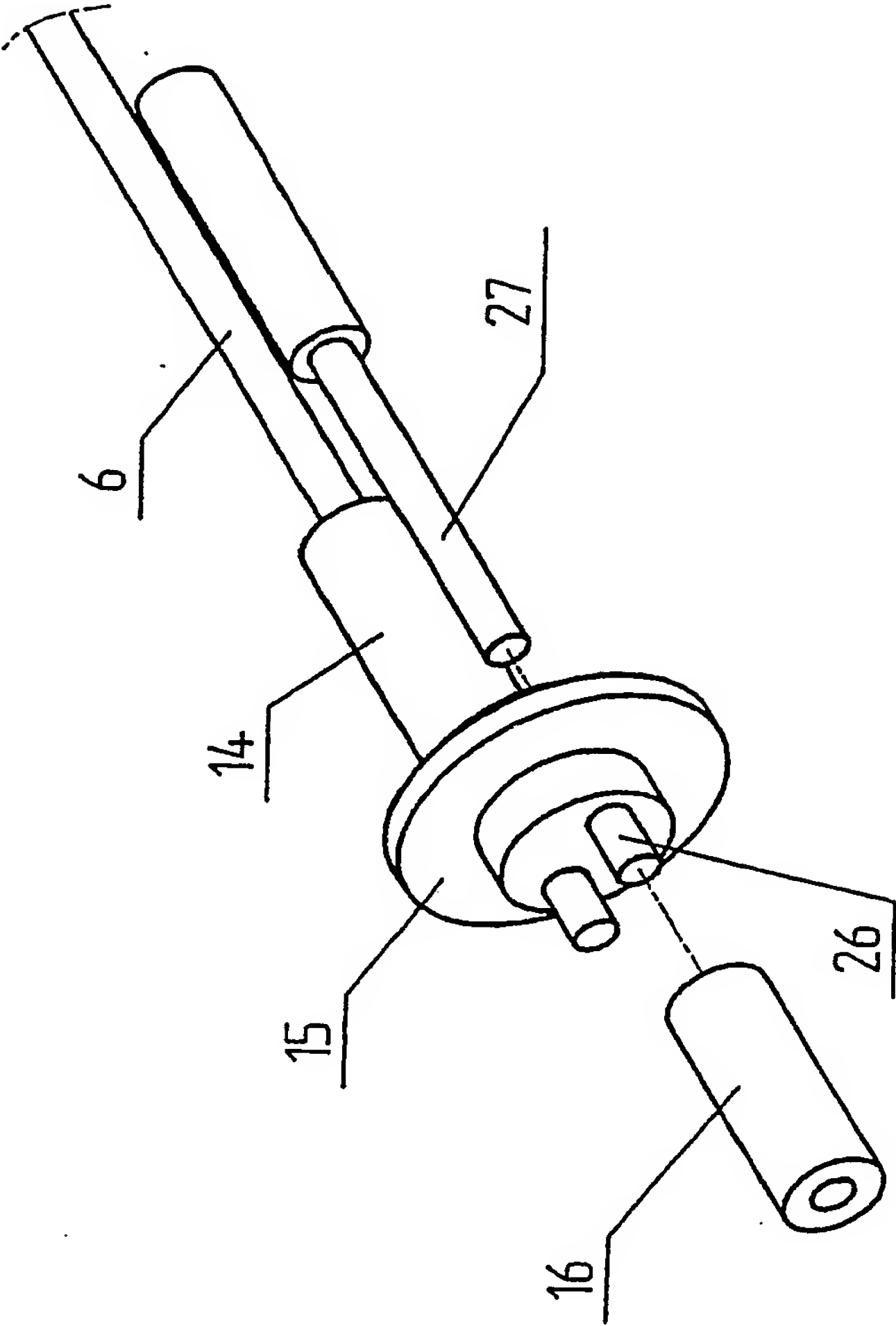


Fig. 3

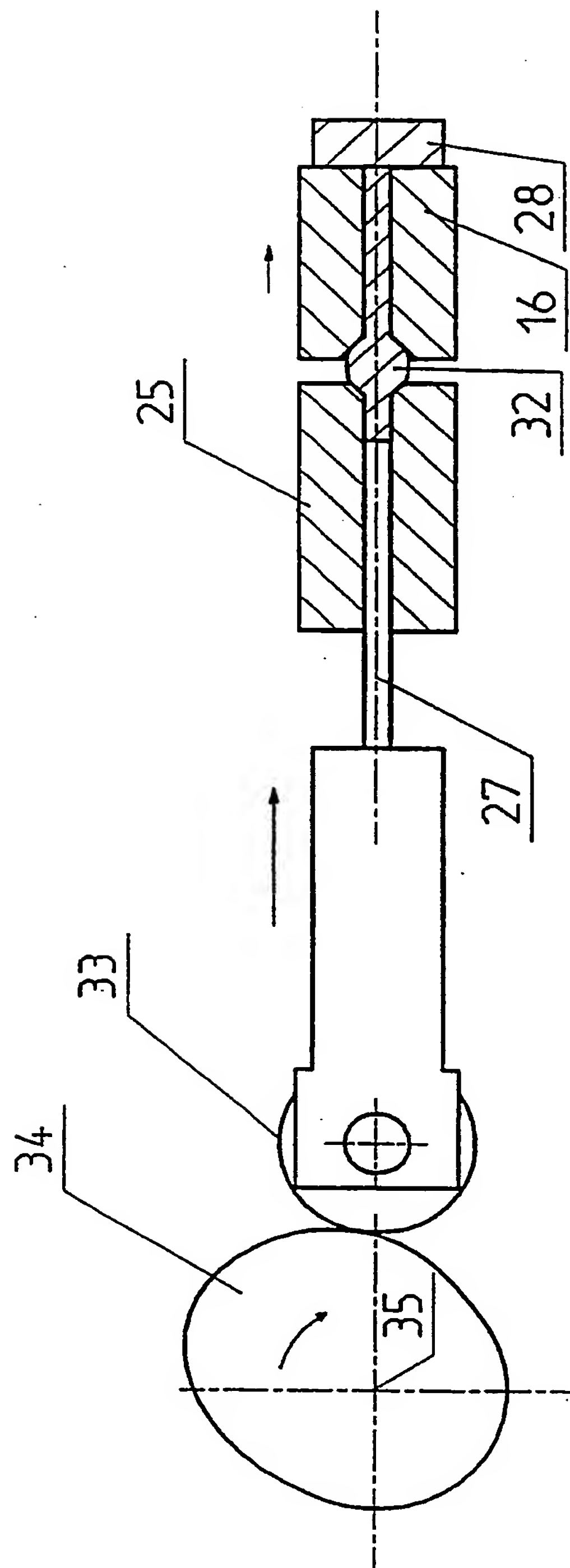


Fig. 6

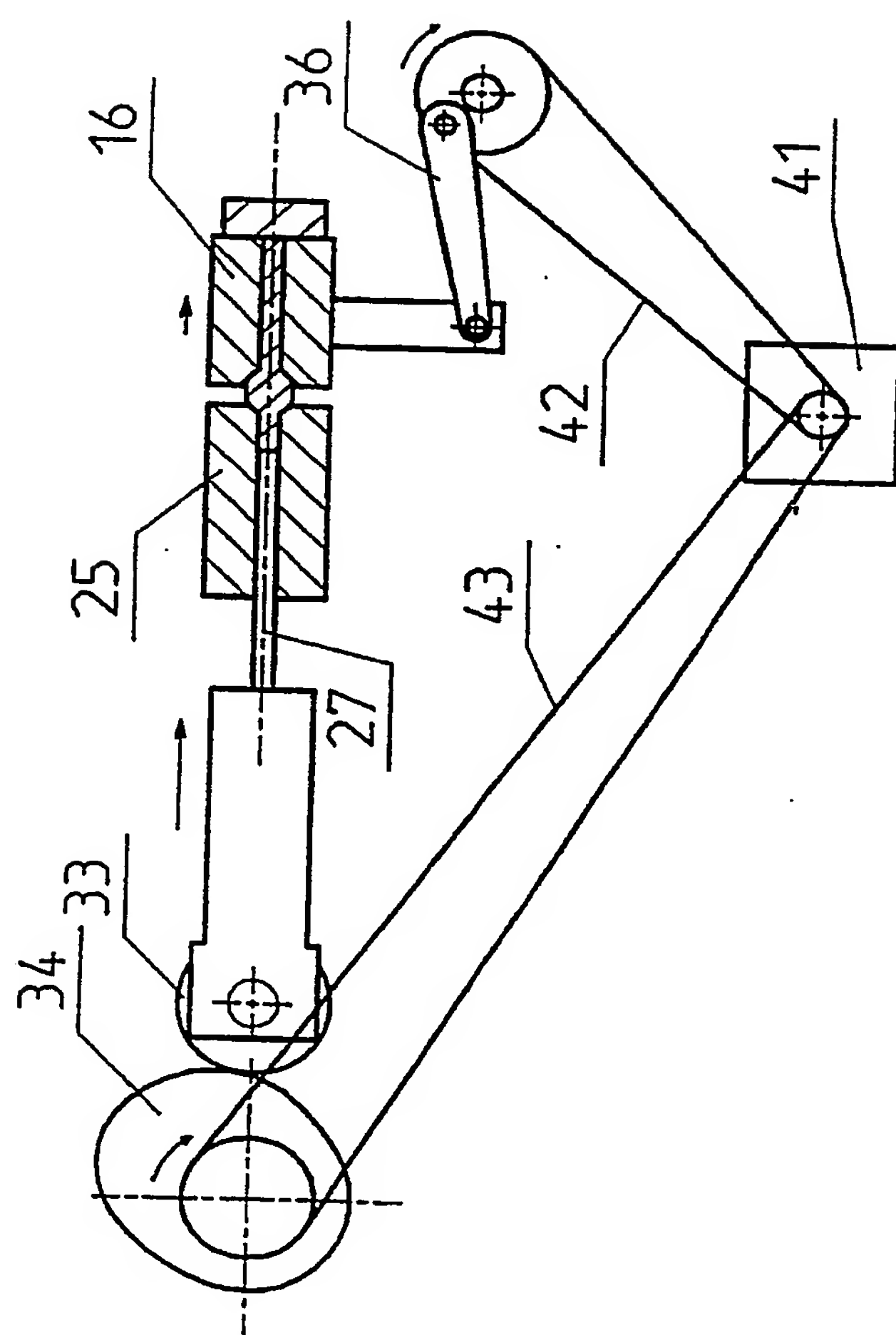


Fig. 8

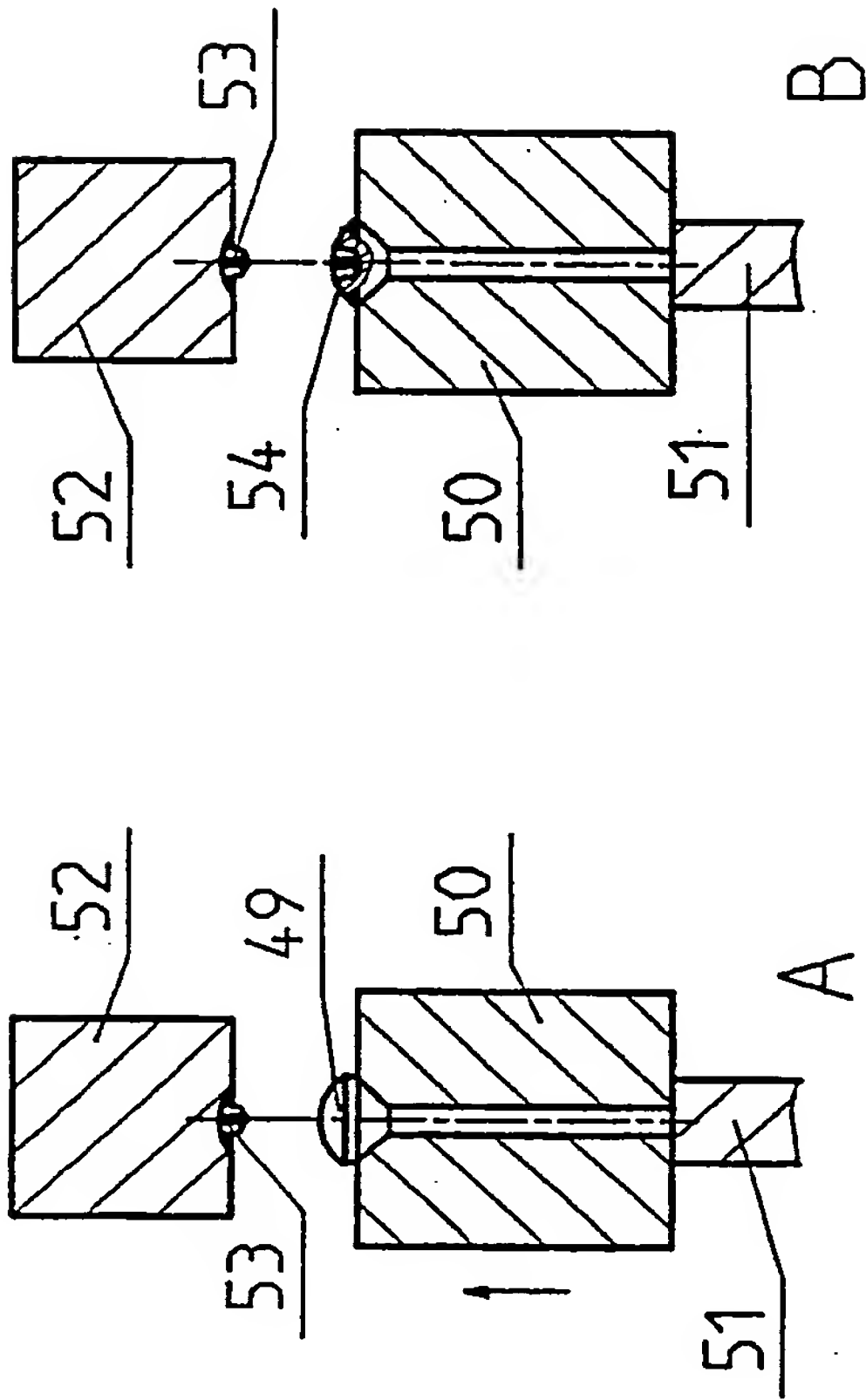


Fig. 10

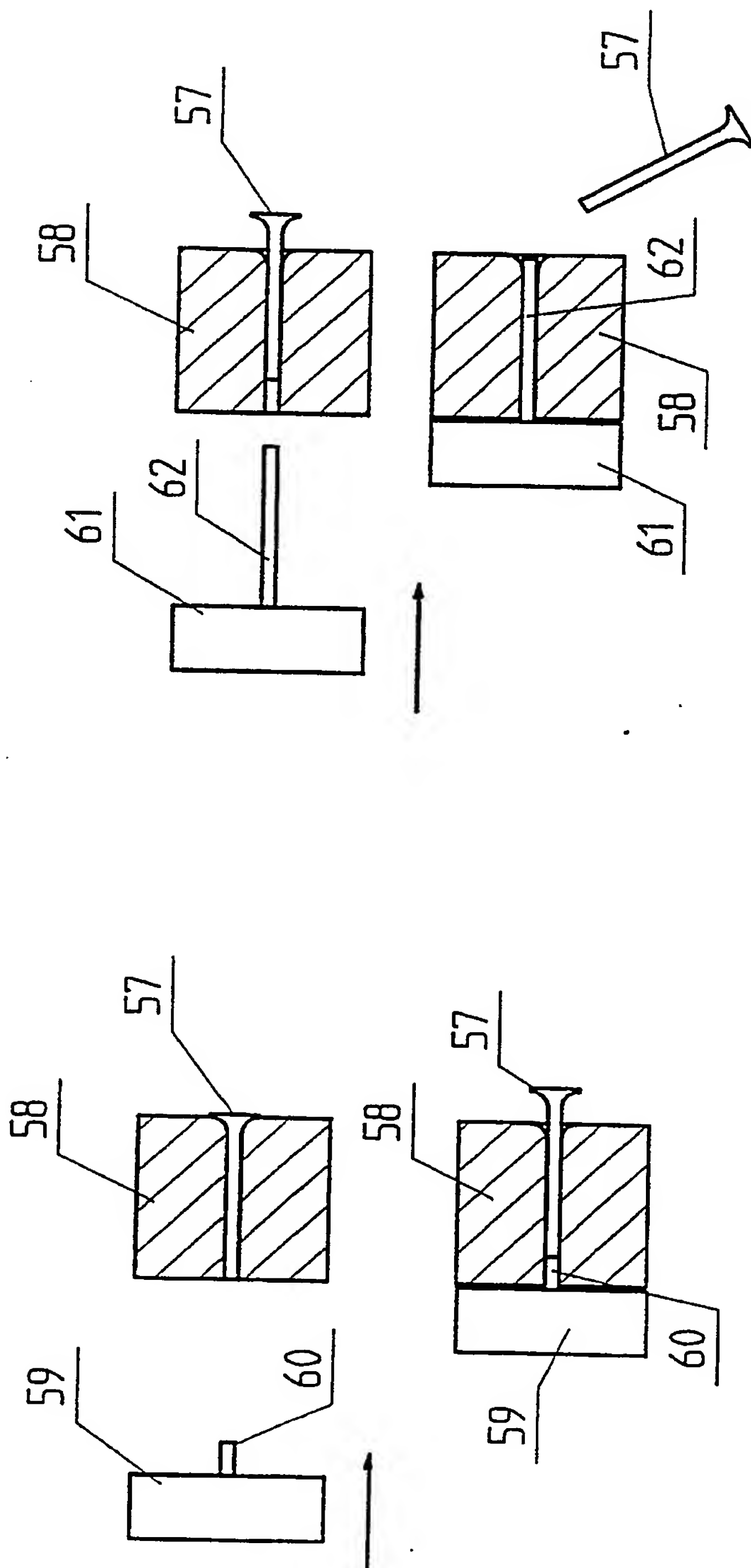


Fig. 12

Fig. 13

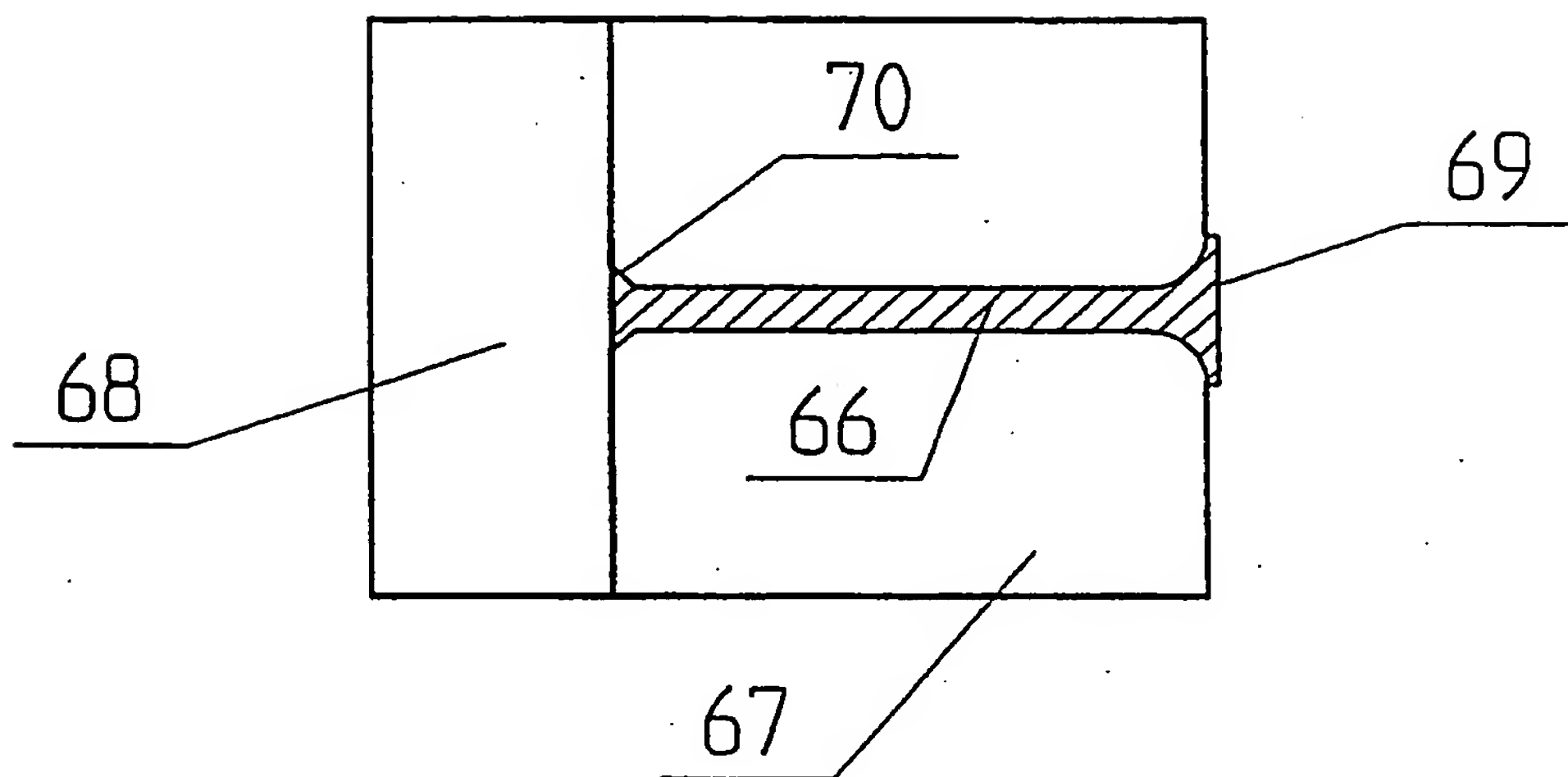


Fig. 15

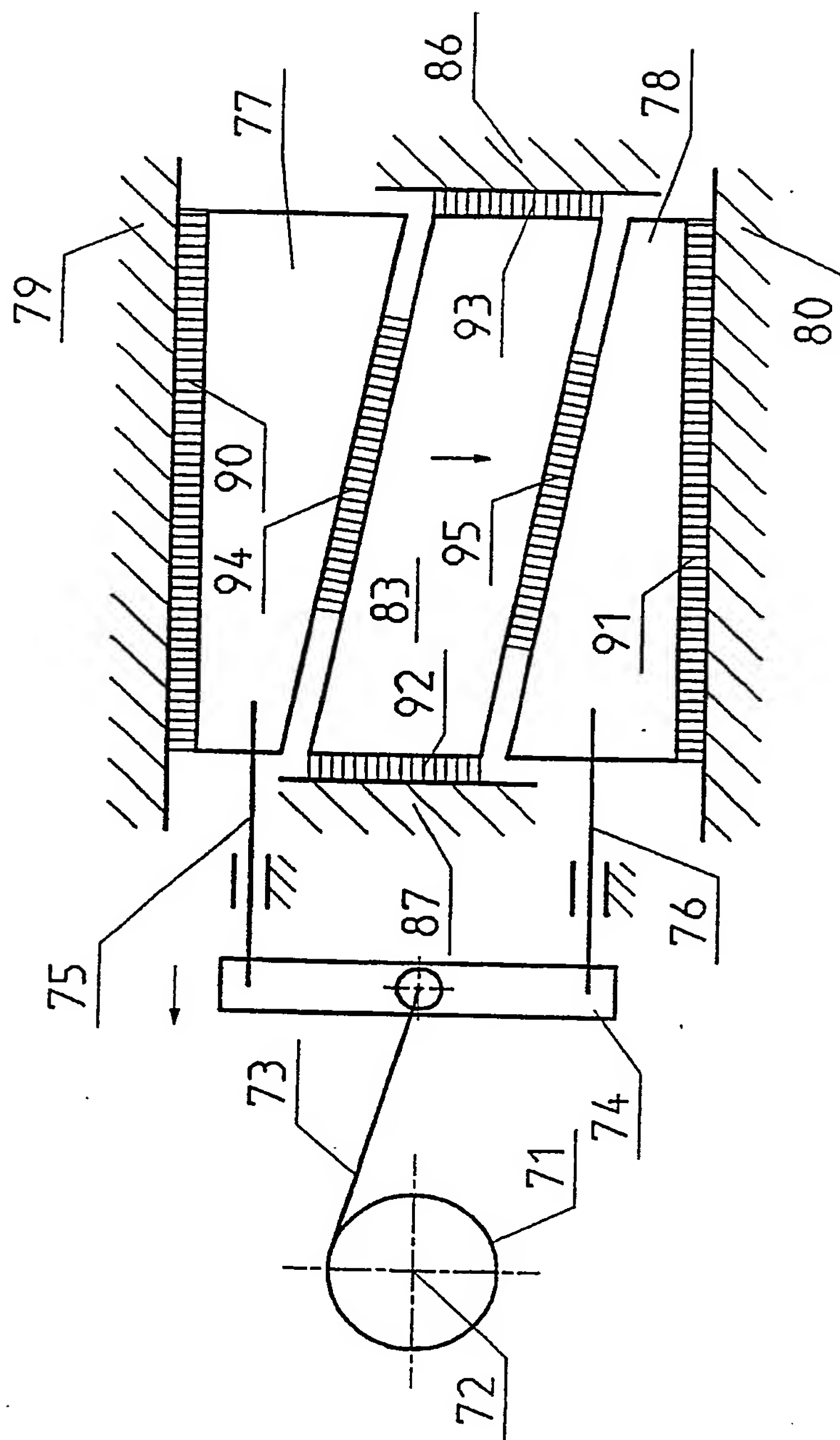


Fig. 17

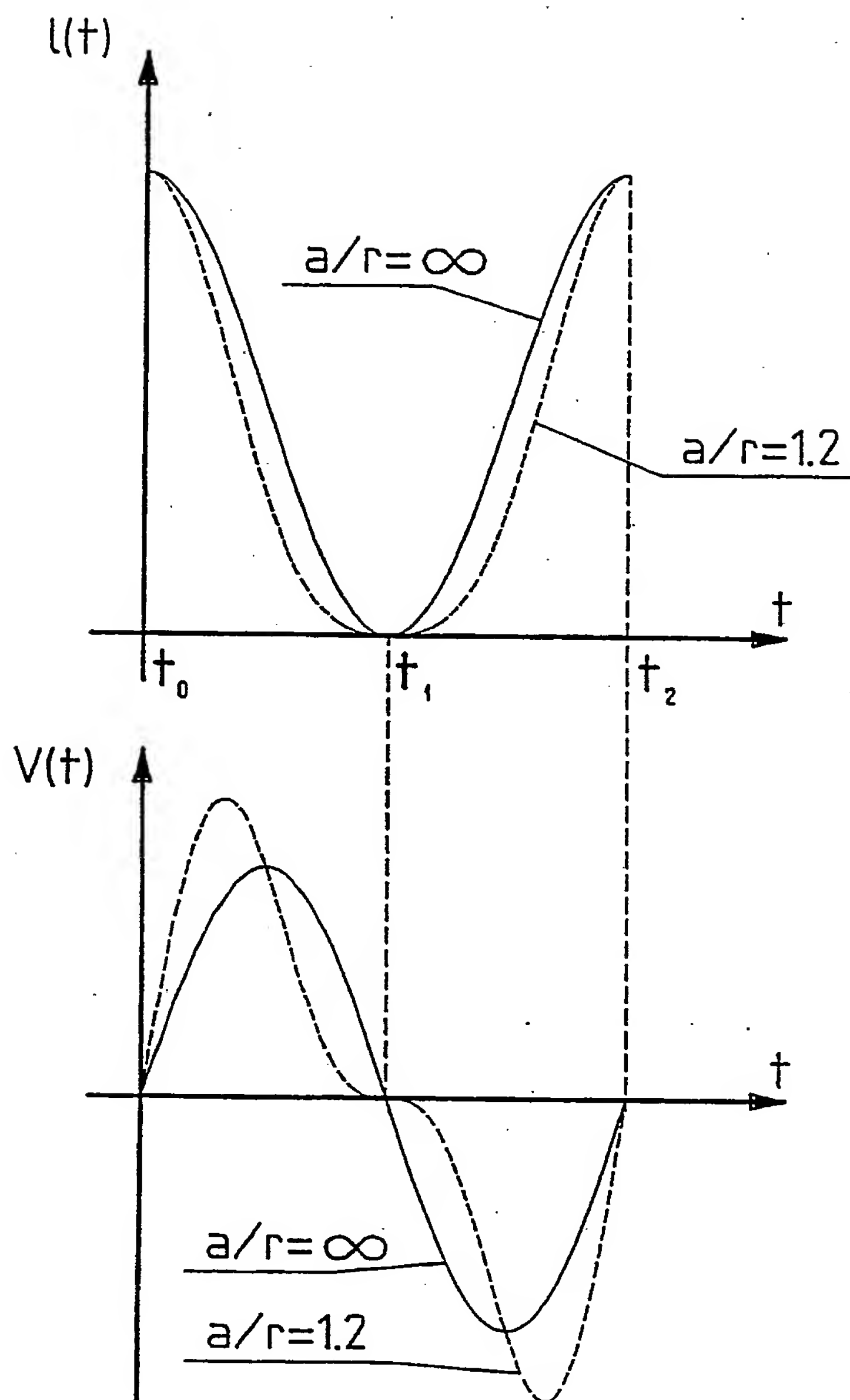


Fig. 19

Fig. 21

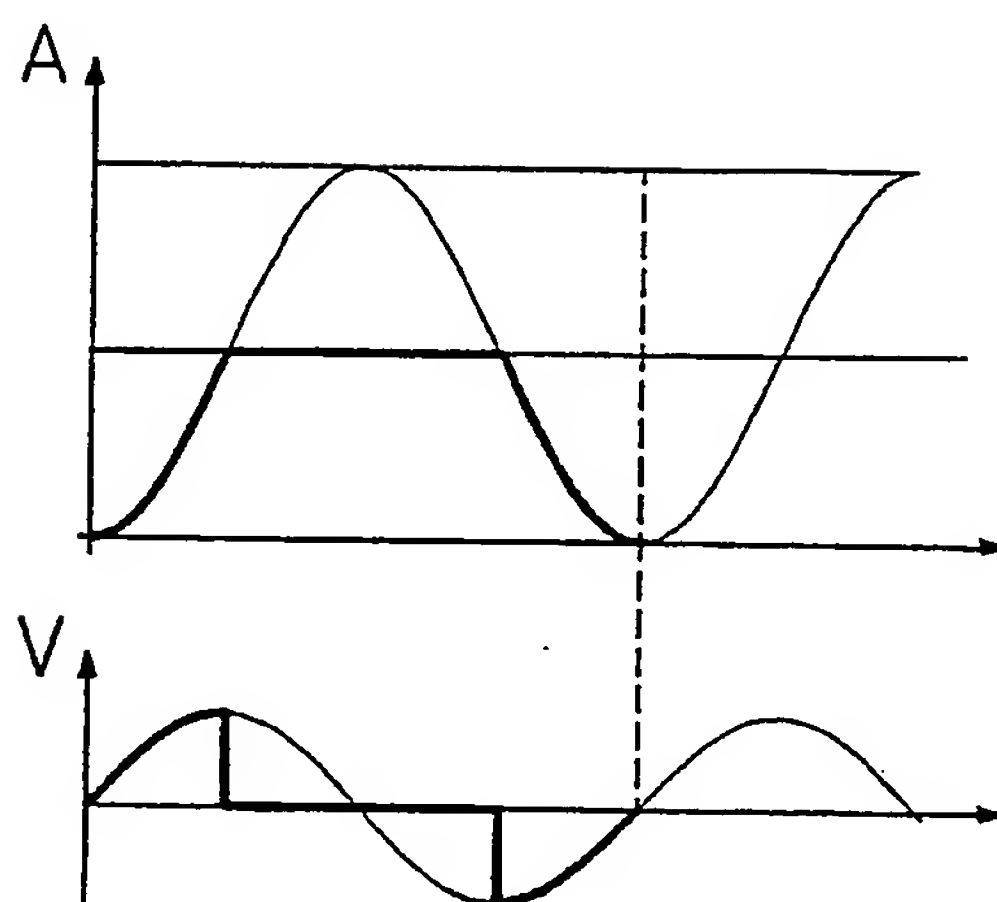


Fig. 22

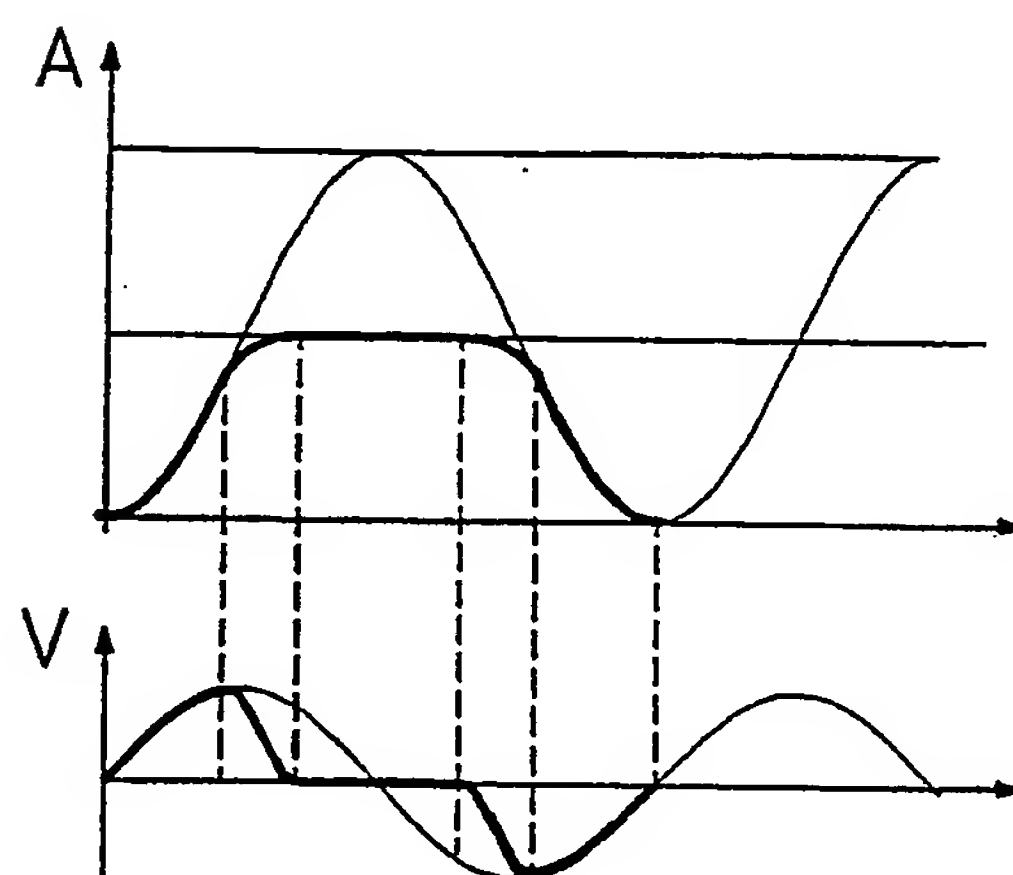
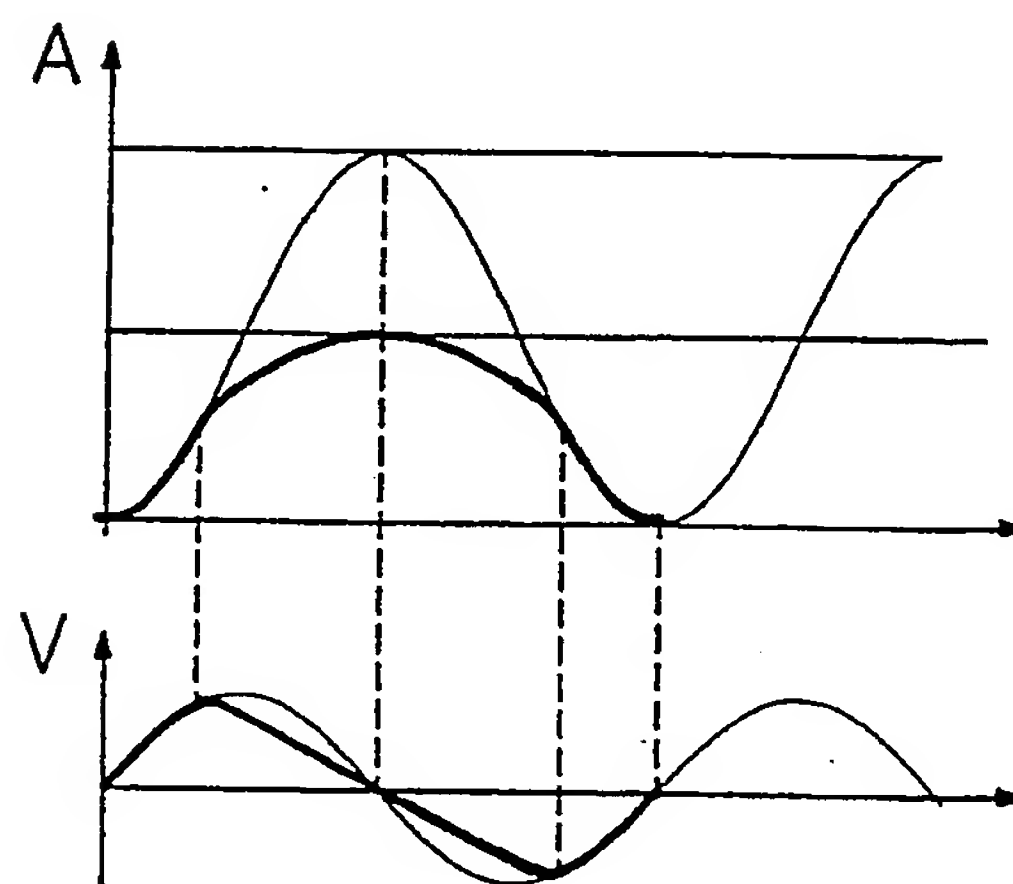


Fig. 23



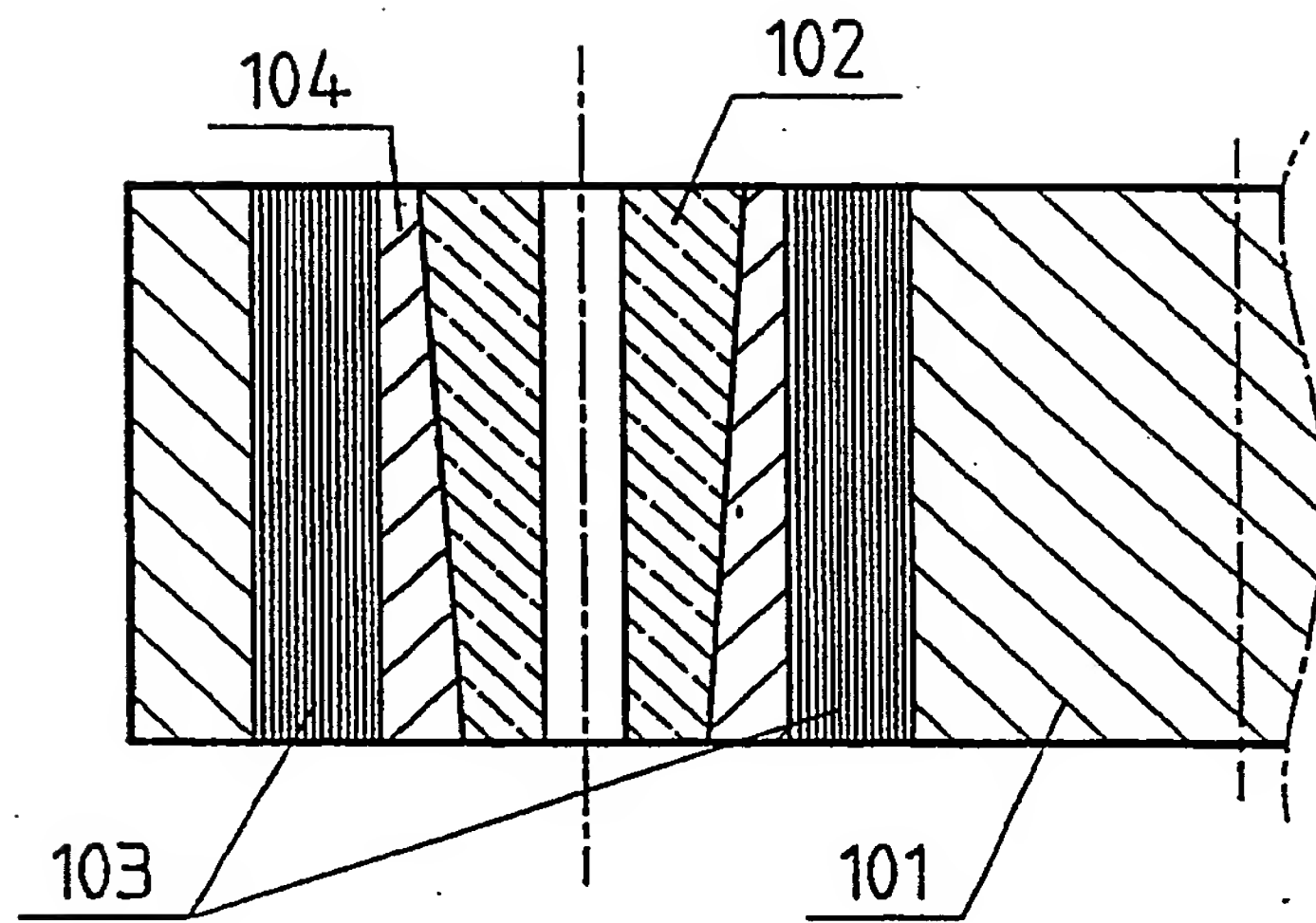


Fig. 25

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 93/00079

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B21J 5/02, B21J 5/08, B21K 1/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B21J, B21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 3127626 (ROBERT G. FRIEDMAN), 7 April 1964 (07.04.64), column 3, line 20 - line 28; column 6, line 14 - line 69, figures 9,10	1,3
A	--	2,4
X	US, A, 3253287 (ROBERT G. FRIEDMAN), 31 May 1966 (31.05.66), column 3, line 17 - line 29; column 4, line 21 - column 5, line 39, figures 1-4	1,3
X	US, A, 3471878 (WILLIAM M. HERPICH), 14 October 1969 (14.10.69), column 2, line 60 - column 3, line 35; column 4, line 8 - line 45, figures 1,2,7	1,3
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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INTERNATIONAL SEARCH REPORT

Information on patent family members

31/03/93

International application No.

PCT/DK 93/00079

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	3127626	07/04/64	NONE		
US-A-	3253287	31/05/66	NONE		
US-A-	3471878	14/10/69	BE-A-	702191	02/02/68
			GB-A-	1205802	16/09/70
			NL-A-	6709891	16/04/68
			SE-B,C-	380989	24/11/75
DE-C-	917590	06/09/54	NONE		
DE-C-	933430	22/09/55	NONE		

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